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EVAPORATION MEMORANDUM NO 33

DUPLICATE

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Hydrologically effective rainfall on grassland at Kew Observatory 1871-1976.

1. Introduction

The definition of hydrologically effective rainfall accepted in the Meteorological Office is the difference between total rainfall and (Penman) potential evaporation when the soil is at field capacity, i.e. when there is estimated to be no deficit of soil moisture. For the Penman estimates the albedo is taken as .25 for grassland. Hydrologically effective rainfall; as defined above, is considered to contribute to streamflow, surface water storage and groundwater.

2. Calculations

Monthly totals of potential evaporation (P.E.) were calculated for Kew using the wind speed measured at 2m above ground, average daily duration of bright sunshine, average vapour pressure, average saturation vapour pressure and average screen temperature. These P.E. totals were apportioned to individual days on the basis of the average match of potential evaporation and then balanced against daily rainfall values. The reduction of actual evaporation below potential evaporation as soil moisture tension developed was modelled by the use of Penman's root constant model using a value of 76.2 mm as the equivalent depth of water which can be extracted from the soil, without difficutly by the roots of grass. The computer program outputs daily soil moisture deficit, actual evaporation and effective rainfall.

3. Data

The estimates of monthly totals of hydrologically effective rainfall are tabulated in the data sheets and a simple analysis of the distribution of values is also given.

August 1976

MET.O DUP 2A

3 8078 0001 4572 4

(GRASSLAND)
HYDROLOGICALLY
EFFECTIVE mm.
RAINFALL 1871

1. Penman p.e. using albedo 0.25 and 2m wind speeds.
2. Daily rainfall
3. Penman root constant 76.2mm - 1880

Station name KEW OBSERVATORY.. County .....

Altitude ..... ft .....m NGR ..... No .....

	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	
January	42.3	54.1	49.3	19.0	79.4	19.9	115.4	25.3	64.5	9.8	
February	15.4	6.3	22.8	15.0	12.4	37.5	29.8	21.6	89.7	45.8	
March	4.0		8.8		5.0	33.9	26.8	1.1		3.9	
April							30.0	45.8	36.6		
May		2.5						26.0	31.0		
June								4.0	30.9		
July									43.8		
August								26.2	44.9		
September									27.7		
October								15.2	1.0	97.9	
November		50.6	1.8	16.3	59.4		6.3	56.6	12.4	37.4	
December		88.5	9.9	25.4	22.7	124.9	32.0	29.6	16.8	78.0	
TOTAL											

RAINFALL 1 - 1

Station name..... County .....

Altitude ..... ft .....m NRG ..... No .....

	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	
January	13.2	28.1	49.9	47.5		84.7	36.0	16.1	19.3	48.1	
February	54.9	25.5	75.8	23.2	53.6	10.2	5.6	14.5	39.6	16.4	
March	30.8	2.8	0.2	16.8	15.2	1.2	10.6	40.1	9.6	8.9	
April						3.6	0.4	20.5	9.7		
May		0.1				10.7			4.4		
June											
July										0.2	
August											
September											
October		33.5			26.2						
November	50.8	48.4	12.2		67.2			58.0	11.6		
December	63.1	48.5	11.5		27.3	79.2	30.5	34.8	29.7		
TOTAL											

RAINFALL 1 - 1

Station name ..... County .....

Altitude ..... ft .....m NGR ..... No .....

	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
January		4·6	29·1	68·3	31·5	8·3	44·7		51·5	68·8
February		24·3	53·3	25·1	0·6		46·1		43·4	68·6
March				17·4		38·0	64·1	6·7		0·8
April										
May										
June										
July										
August										
September										
October	42·7	34·8				15·4				
November	41·8	65·1		60·3	43·1	19·3			22·1	
December	69·0	27·7	50·6	47·1	42·6	73·1		47·8	27·4	
TOTAL										

RAINFALL 1 - 1

Station name..... County .....

Altitude ..... ft .....m NMS ..... No .....

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
January	16·1	9·9	50·1	52·3	24·2	82·4	13·2	38·9	12·3	37·5
February	14·2	10·5	7·8	47·3	0·7	32·6	19·8	12·9		55·5
March	16·8	16·7	26·0	4·2	57·3	6·2	2·7	30·9	33·2	12·2
April	21·6						14·9	6·7		
May			7·3				5·2			
June			120·7							
July										
August			12·0							
September			25·2							
October			115·4							
November			36·6			34·9	12·6			
December		3·7	35·3		8·7	45·7	88·5		47·8	75·4
TOTAL										

RAINFALL 1 - 1

Station name ..... County .....

Altitude ..... ft .....m NGR ..... No .....

	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	
January	24·9	80·5	58·8	6·4	95·5	24·8	21·0	70·9	85·5	45·4	
February	19·6	17·8	12·5	50·8	66·8	62·9	4·6	9·0	45·1	1·0	
March	13·8	87·9	9·5	71·6	7·9	78·1	16·7		51·8	5·0	
April	14·2		9·9	1·5			27·8	36·5	13·7	14·1	
May			10·8						0·6		
June											
July											
August											
September											
October		12·3				8·7	51·7	43			
November	2·4	30·4	18·5		19·1	96·4	24·9	48·7			
December	105·1	60·0	15·6	122·7	126·8	55·3	26·1	47·8		43·5	
TOTAL											

RAINFALL 1 - 1

Station name..... County .....

Altitude ..... ft .....m NRG ..... No .....

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	
January	40·9		20·6	61·5	38·9	57·1	42·5	73·7	16·2	61·7	
February		15·2	59·4		66·1	47·0	76·7	28·5	3·5	9·1	
March		27·9	29·3				23·5	7·6		10·3	
April		9·8	1·1	21·9			24·8	2·2		6·5	
May				1·6						0·4	
June				23·1							
July											
August											
September							5·7				
October			1·4	37·1	14·0		13·1				
November			34·1	47·5	33·8	44·2	62·0		40·9	11·5	
December			49·3	70·9	67·8	3·4	88·9	55·9	106·0	43·8	
TOTAL											

RAINFALL 1 - 1

Station name ..... County .....

Altitude ..... ft .....m NGR ..... No .....

	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
January	23.0	37.3	29.8		16.8	92.0	87.4	47.5	100.4	58.4
February	26.5		54.8		38.9	29.8	88.2		8.5	30.5
March			34.1		0.9	0.8	48.9		1.6	58.2
April	19.6	4.2			7.8	1.5	8.0		9.8	
May		32.8								
June										
July										
August										
September										
October		17.0								
November	29.8	14.9			51.1	47			92.8	84.6
December	7.7	8.5		8.4	51.6	34.7	72.0	72.5	18.8	21.7
TOTAL										

RAINFALL 1 - 1

Station name..... County .....

Altitude ..... ft .....m NRG ..... No .....

	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
January	57.6	46.1	114.9	28.5	37.0	25.2	30.8	23.8	18.5	15.3
February	35.0	13.2	28.0	5.4	29.5	39.8	24.1	25.2	12.0	69.5
March	57.2	12.0				9.8	86.9		6.8	
April	16.3						15.1			
May										
June										
July										
August	7.6									
September						22.9				
October						1.9				
November	15.0	2.1		28.3		91.0			42.5	22.2
December	36.5	53.8		29.5		48.1		10.7	34.0	33.2
TOTAL										

RAINFALL 1 - 1

Station name ..... County .....

Altitude ..... ft .....m NGR ..... No .....

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	70·2	43·4	18·2	15·4	41·4	71·4	29·2	41·4	52·6	36·3
February	118·1	14·3	23·4	38·3	18·0		62·6	43·3		29·3
March	47·0	39·0		20·9		1·4			7·1	14·0
April	23·5			2·9				12·5		
May										
June										
July										
August										
September										
October						18·4		11·2		36·4
November	44·2	44·3		26·8				42·5		84·2
December	35·4	64·2		44·7		52·7	39·1	73·3	15·1	47·0
TOTAL										

RAINFALL 1 - 1

Station name..... County .....

Altitude ..... ft .....m NRG ..... No .....

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
January	53·9	65·5	11·6	6·9		22·7	28·0	51·5	58·6	44·1
February	36·8	5·5	1·8	3·5		50·7	34·3	14·9	28·7	23·1
March			16·9	58·7			13·1		33·7	13·4
April		2·9		20·2		23·6				10·0
May										
June										
July										
August										
September										
October								23·2		
November			15·5		4·1	5·0	2·4	28·8		27·8
December	43·9	38·5	11·6		91·1	64·7	52·3	68·2		34·8
TOTAL										

RAINFALL 1 - 1

Station name ..... County .....

Altitude ..... ft .....m NGR ..... No .....

	1971	1972	1973	1974	1975	1976	1	1	1	1
January	62·5	47·4		23·9	70·8	7·5				
February	4·9	35·8		53·9	19·2	6·7				
March	17·5	16·6		8·9	39·1					
April					0·3					
May					3·6					
June	7·4									
July										
August										
September										
October				7·2						
November				125·0	23·4					
December	3·6			22·1	24·7					
TOTAL										

RAINFALL 1 - 1

Station name..... County .....

Altitude ..... ft .....m NRG ..... No .....

	1	1	1	1	1	1	1	1	1	1
January										
February										
March										
April										
May										
June										
July										
August										
September										
October										
November										
December										
TOTAL										

Numbers of cases of hydrologically effective rainfall on grassland at Kew (mm) 1871–1976 between shaded limits.

1. Winter half-year Oct–Mar

0–50	51–100	101–150	151–200	201–250	251–300	301–350	mm.
13	19	25	21	10	15	2	105 yrs. (winters)

2. Summer half-year Apr–Sep

0–50	51–100	101–150	151–200	201–250	251–300	301–350	mm.
102 (60 zero)		1	1	1			

	0–20	21–40	41–60	61–80	81–100	101–120	mm.	Years
JAN	30	26	27	14	7	2		106
FEB	50	29	16	8	2	1		106
MAR	39	16	8	2	1			106
APR	96	9	1					106
MAY	103	3						106
JUN	103	2				1		106
JUL	105		1					106
AUG	103	1	1					105
SEP	102	3						105
OCT	95	6	2		1	1		105
NOV	63	16	17	3	5		1	105
DEC	36	24	22	14	4	2	3	105

Driest 13 winter half-years (0–50.9 mm.)

Winter	mm	Winter	mm
1890–91	0	1901–02	37.1
1933–34	0	1921–22	43.1
1964–65	0	1908–09	45.5
1972–73	0	1873–74	45.7
1897–98	6.7	1900–01	47.1
1943–44	33.9	1948–49	48.0
		1947–48	49.0

Hydrologically effective rainfall on grassland at Kew (mm)

A-S = Apr - Sep, O-M = Oct - Mar (following year).

	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880
A-S		2.5					30.0	102.0	214.9	
O-M	60.4	220.0	45.7	138.5	173.4	296.9	86.3	254.5	89.7	312.2

	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890
A-S		0.1				14.3	0.4	20.5	14.1	0.2
O-M	170.3	256.3	111.2	68.8	216.8	131.4	101.2	161.3	114.7	X

	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
A-S										
O-M	182.4	210.0	161.4	139.5	132.0	249.7	6.7	142.7	187.7	47.1

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
A-S	21.6		165.2				20.1	6.7		
O-M	37.1	87.6	291.1	82.2	129.9	116.3	183.8	45.5	153.0	133.7

	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
A-S	14.2		20.7	1.5			27.8	36.5	14.3	14.1
O-M	244.7	183.5	162.9	292.9	311.7	202.7	182.6	283.2	51.4	84.4

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
A-S		9.8	1.1	46.6			30.5	2.2		6.9
O-M	43.1	109.3	146.3	260.5	219.7	189.3	273.8	75.6	228.0	104.8

	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
A-S	19.6	37.0			7.8	1.5	8.0		9.8	
O-M	74.8	159.1	X	65.0	225.3	263.9	119.5	183.0	258.7	256.1

	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
A-S	23.9					22.9	15.1			
O-M	127.8	198.8	33.9	124.3	74.8	282.8	49.0	48.0	161.3	290.7

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
A-S	23.5			2.9				12.5		
O-M	176.3	150.1	74.6	130.9	72.8	162.9	123.8	186.7	94.7	258.3

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
A-S		2.9		20.2		23.6				10.0
O-M	114.9	68.8	96.2	X	168.6	145.1	121.1	241.2	80.6	147.5

	1971	1972	1973	1974	1975	1976
A-S	7.4				3.9	
O-M	103.4	X	86.7	283.4	62.3	